

UTILITY PATENT APPLICATION TRANSMITTAL LETTER

(Only for new nonprovisional applications under 37 CFR 1.53(b))

Docket No.
1014U-416**To the Assistant Commissioner for Patents:**

Transmitted herewith for filing is the patent application of:

Koji KANEKO and Mitsuhiro OHNO
corresponding to Japanese application 11-089307, filed March
30, 1999,
entitled: OPTICAL SCANNING DEVICE

Enclosed are:

<input checked="" type="checkbox"/>	11 pages of specification.
<input checked="" type="checkbox"/>	5 sheets of formal drawings.
<input type="checkbox"/>	a newly-executed declaration of the inventor.
<input type="checkbox"/>	a copy of an executed declaration of the inventor from prior application Serial No. , filed .
<input type="checkbox"/>	incorporation by reference. The entire disclosure of the prior application, from which a copy of the oath or declaration is supplied as indicated in the preceding box, is considered as being part of the disclosure of the accom- panying application and is hereby incorporated by reference therein.
<input type="checkbox"/>	an assignment of the invention to , including assignment cover sheet.
<input type="checkbox"/>	Information Disclosure Statement with Form PTO-1449.
<input type="checkbox"/>	copies of the Information Disclosure Statement citations.
<input type="checkbox"/>	preliminary amendment.
<input checked="" type="checkbox"/>	return receipt postcard (MPEP 503), specifically itemized.
<input type="checkbox"/>	a verified statement to establish small entity status under 37 CFR 1.9 and 1.27.
<input type="checkbox"/>	a verified statement to establish small entity status filed in prior application. Status is still proper and desired.
<input type="checkbox"/>	a certified copy of the Priority Document.
<input checked="" type="checkbox"/>	other: this application is filed without a declaration in order to preserve Convention priority.

If a CONTINUING APPLICATION, check appropriate box and supply the requisite informa-
tion.☐ Continuation ☐ Divisional ☐ Continuation-in-part (CIP)

of prior application No. , filed .

<input checked="" type="checkbox"/>	Customer No. 000466.
<input checked="" type="checkbox"/>	Correspondence address is: YOUNG & THOMPSON, 745 South 23rd Street, Second Floor, Arlington, Virginia 22202.
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UTILITY PATENT APPLICATION TRANSMITTAL LETTER
(continued)

Docket No.
1014U-416

CLAIMS AS FILED

	NO. FILED	NO. EXTRA	RATE	FEE
BASIC FEE			\$ 690	\$ 690
TOTAL CLAIMS	13 - 20 =	0	X\$ 18	0
INDEPENDENT CLAIMS	2 - 3 =	0	X\$ 78	0
MULTIPLE DEPENDENT CLAIM PRESENT			\$ 260	

TOTAL \$ 690

If applicant has small entity status under 37 CFR 1.9 and 1.27, then divide total fee by 2, and enter amount here.

**SMALL ENTITY
TOTAL**

\$

X

A check in the amount of \$690 to cover the filing fee is enclosed.

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Charge the amount of \$ as filing fee.

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Credit any overpayment.

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Charge any additional fee required under 37 CFR 1.16 and 1.17, during the pendency of this application.

Charge the issue fee set in 37 CFR 1.18 at the mailing of the Notice of Allowance.



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March 28, 2000

Table 1. Demographic characteristics of the study population	
Age (years)	50.0 ± 10.0
Gender	
Male	50.0%
Female	50.0%
Marital status	
Married	80.0%
Single	20.0%
Education level	
High school or above	80.0%
Below high school	20.0%
Occupation	
White collar	60.0%
Blue collar	40.0%
Income (USD/month)	
< 1000	20.0%
1000-2000	40.0%
> 2000	40.0%
Health insurance	
Yes	80.0%
No	20.0%
Smoking status	
Smoker	30.0%
Non-smoker	70.0%
Alcohol consumption	
Regular	10.0%
Occasional	20.0%
Never	70.0%
Family size	
1-2	30.0%
3-4	40.0%
5 or more	30.0%
Chronic diseases	
Hypertension	20.0%
Diabetes	10.0%
Heart disease	15.0%
Other	5.0%
Current medications	
Yes	30.0%
No	70.0%
Stress level	
High	40.0%
Low	60.0%

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Citizenship::	JAPANESE

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APPLICATION INFORMATION

Title Line One:: OPTICAL SCANNING DEVICE
Total Drawing Sheets:: 5
Formal Drawings:: Y
Application Type:: UTILITY
Docket Number:: 1014U-416

REPRESENTATIVE INFORMATION

Representative Customer Number:: 000466

PRIOR FOREIGN APPLICATION

Foreign Application One:: 11-089307
Filing Date:: MARCH 30, 1999
Country:: JAPAN
Priority Claimed:: Y

OPTICAL SCANNING DEVICE

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to improvements in an optical scanning device for scanning a subject medium.

1. Description of the Related Art

In recent years, with development of digital techniques and light sources, numerous high performance printing equipment and the like have been developed, wherein a scanning beam modulated according to image signals scans a subject matter, such as photographic pictures and printed matter (which is hereafter referred to as a scanning subject medium), that is sensitive to light to record an image on a paper. In such a printing equipment, the utilization is made of an optical scanning device to scan a scanning subject medium. This optical scanning device is, for typical example, configured such that a laser beam from a laser diode is repeatedly reflected and deflected by a rotary polygon mirror and further directed as a scanning beam to a subject medium through an $f-\theta$ lens.

In this type of optical scanning device, the polygon mirror that rotates at a speed sufficiently high causes a strong current of air therearound. In the case where the polygon mirror is received in a somewhat isolated chamber, the strong current of air hits against walls of the isolated chamber, or even in the case where the polygon mirror is placed in an

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open space, the current of air strikes parts laid around the polygon mirror, the current of air gets disturbed with an adverse effect of causing irregular rotation, or fluctuations of rotation, of the polygon mirror, which leads to unevenness of scanning on a subject medium, and hence inaccurate scanning. Although it is thought to dispose the polygon mirror in a spacious place in the housing on the ground of this problem, it is undesirable in light of miniaturization of the optical scanning device.

A polygon mirror and an electric motor are usually previously assembled and attached to a base board 18 as one whole of polygon mirror unit for easy installation and removal and/or easy replacement upon an occurrence of break-down. The polygon mirror unit is usually installed to a precise mount provided within a body housing with an intention to place and adjust the polygon mirror in position accurately relative to a scanning beam projection optical system and a scanning optical system. Fluctuations of rotation of the polygon mirror had been a great problem in the optical scanning device of this type. For the purpose of providing a brief background that will enhance an understanding of the behavior of a current of air caused by a polygon mirror in an isolated chamber, reference is made to Figure 7.

As shown in Figure 7, a polygon mirror unit 300 which comprises an electric motor 319, a polygon mirror 317 integrated with an output shaft (not shown) of the electric motor 319, and a base board 318 on which the electric motor 319 secured is installed to a mount 310 provided within a dust free chamber 320. The mount 310 comprises U-channel support frames 310a arranged with an separation therebetween. The base board 318 at its four corners is secured to the U-channel support frames 310a by fastening bolts 310b. There are

for mounting the polygon mirror unit thereon through the base board, the mounting means being configured to prevent generation of turbulence of a current of air that is generated due to high speed rotation of the polygon mirror.

Specifically, the mounting means comprises a support frame which is configured in conformity with the base board so as to support the base board thereon from the back in a condition where the support frame is nearly in contact with a strip-like periphery of the base board, and a fitting frame which is configured in conformity with the base board so that the base board is fitted therein. The support frame may be provided with setting surfaces uneven with the support frame at four corners thereof so as to be in contacts with the base board at the four corners only. It is preferred that the difference between the setting surfaces and the support frame is less than approximately 0.5 mm. Further, the fitting frame may have a depth equal to a thickness of the base board. The mounting means is preferably provided in a recess formed in a bottom floor of the dust proof chamber.

According to the optical scanning system of the invention, even when the polygon mirror causes such a current of air as hitting against walls of the dust proof chamber and further generates turbulence of the current of air, the unique structure of the mount means prevents the current of air from penetrating under the base board and is never conducive to encouragement of the turbulence of the current of air. Accordingly, the base board is free from distortion, so as to keep the polygon mirror from fluctuations of rotation, as a result of which the optical scanning device is accurate and stable in scanning operation.

BRIEF DESCRIPTION OF THE DRAWINGS

The above and other objects and features of the present invention will be more apparent from the following detailed description in connection with a preferred embodiment thereof when reading in conjunction with the accompanying drawings, in which:

Figure 1 is a top view of an optical scanning device with a top cover removed away;

Figure 2 is a front view of the optical scanning device;

Figure 3 is a cross-sectional view of Figure 1 taken along a line III - III;

Figure 4 is an enlarged view of a dust proof chamber with a polygon mirror unit installed therein;

Figure 5 is a plan view of a step mount of the dust proof chamber;

Figure 6 is a cross-sectional view of the dust proof chamber of Figure 5 taken along line VI - VI; and

Figure 7 is an enlarged view of a prior art dust proof chamber.

DETAILED DESCRIPTION OF THE INVENTION

Referring to the drawings in detail, and in particular to Figures 1 to 3 showing an optical scanning device 100 equipped with an $f-\theta$ lens system in accordance with a preferred embodiment of the present invention, the optical scanning device 100, which is typically detachably fitted in a rectangular recess of an apparatus such as a printer schematically shown at 200 in Figure 3 or put between two associated instruments such as another optical scanning device and a printer, has a generally rectangular parallelepiped box-shaped housing (which is hereafter referred to as a box housing for simplicity) 10. The box housing 10 is provided with a detachable cover 40 which has a generally inverse L-shaped form so as to

cover the top of the box housing 10 and a rear space defined by the rear wall 10b and extensions of the opposite side walls 10c. The box housing 10 at opposite sides is provided with handles 33 and 34 integrally formed therewith for easy handling. Because the optical scanning device 100 has to provide a space sufficiently large for movement of scanning beam between the optical scanning device 100 and an instrument 200 to which the optical scanning device 100 is installed, the box housing 10 is preferably shaped to have a large width in a scanning direction and a small depth in a direction in which the optical scanning device 100 is installed to the related instrument 200. The optical scanning device 100 has a scanning optical system which comprises a polygon mirror 17, a scanning beam projection optical system arranged on one side of the polygon mirror 17 close to the laser diode 12, an $f-\theta$ lens system arranged on another side of the polygon mirror 17 which is at an angle of approximately right angle with respect to the side facing to the scanning beam projection optical system, and a scanning timing control optical system. The optical scanning device 100 further has a light source such as laser diode 12 that is mounted on a base board 11 of the box housing 10 so as to project a laser beam L_b along an optical path extending zigzag in a horizontal plane.

The scanning beam projection optical system comprises collimator lens 13, a cylindrical lens 14 and a pair of reflection mirrors 15 and 16 stationarily arranged in order from the laser diode 12 so as to direct the scanning beam L_b to the polygon mirror 17. The $f-\theta$ lens system comprises a first lens element 23, a first reflection mirror 24, a second lens element 25 and a second reflection mirror 26. The box housing 10 is formed with a dust proof chamber 20 for receiving a polygon mirror unit 150 which includes the polygon mirror 17

and the electric motor 19 with a control electric circuit (not shown) pre-assembled together to the base board 18 therein, so as thereby to keep the polygon mirror 17 from dust. These polygon mirror 17, electric motor 19 and electric control circuit are previously attached to the base board 18 as one whole of polygon mirror unit for easy installation and removal and/or easy replacement upon an occurrence of break-down. The dust proof chamber 20 is provided within the box housing 10 and has mounting mean 120 (which will be described in detail later) for mounting the polygon mirror unit thereon. Because the polygon mirror unit has to be installed and adjusted in accurate position relative to the scanning beam projection optical system and the scanning optical system, it is usual to install the polygon mirror unit to precise mounting means rather than installing it directly to the body housing 10. The polygon mirror 17 is directly and firmly secured to a rotary shaft (not shown) of an electric motor 19 that is mounted on the rectangular base board 18 and continuously rotated by the electric motor 19 in a counterclockwise direction as shown by an arrow in Figure 1. As is well known in the art, the polygon mirror 17 reflects the laser beam Lb incident thereupon and deflects it toward the f- θ lens element system. On the top of the base board 18 there are arranged a number of electronic parts forming a control circuit (not shown). Because of installation of the motor and the electronic parts in the interior of the dust proof chamber 20, the dust proof chamber 20 is heated to a somewhat high temperature. On account of a rise in temperature of the dust proof chamber 20, the box housing 10 is integrally formed with, or otherwise provided with, a cooling fin arrangement having a plurality of internal cooling fins 21 arranged in the inside thereof and a heat pipe 22 through which the inside of the dust proof chamber 20 is thermally connected to the cooling fin

arrangement, so as to cool the inside of the dust proof chamber 20. According to the construction of the dust proof chamber 20, although the electric motor 19 and the electronic parts are sealed within the dust proof chamber 20, the polygon mirror 17 is not only kept from dust but prevented from a rise in temperature with which reflective surfaces of the polygon mirror 17 usually cause distortion. The scanning optical system has an $f-\theta$ lens system comprising two lens elements, i.e. the first lens element 23 and the second lens element 25, the first and second reflection mirrors 24 and 26. The first reflection mirror 24 is disposed in the optical axis between the first and second lens elements 23 and 25, and the second reflection mirror 26 is disposed in the optical axis after the second lens element 25. Specifically, as seen in Figure 3, the first lens element 23 is directly fitted and secured in an opening 20b formed in a vertical side wall 20a of the dust proof chamber 20 and the second lens element 25 is secured to a rear vertical wall 10b of the box housing 10. The first reflection mirror 24 is disposed at an upper corner of the box housing 10 between the top of the box housing 10 where the first lens element 23 is disposed and the side of the box housing at which the second lens element 25 is and positioned right above the second lens element 25 so as to turn downward the optical axis at a right angle. The second reflection mirror 26 is disposed at a bottom corner of the box housing 10 between the bottom of the box housing 10 and the rear vertical wall 10b of the box housing 10 to which the second lens element 25 is secured. so as to turn back the optical axis at a right angle. The laser beam Lb reflected and deflected by the polygon mirror 17 passes first through the first lens element 23 forming another part of the $f-\theta$ lens system and then reflected and directed downward at a right angle by the first reflection mirror 24. The laser beam Lb directed

downward further passes the second lens element 25 forming another part of the $f-\theta$ lens system and travels along the rear vertical wall 10b of the box housing 10 until reaching the second reflection mirror 26. Thereafter, the laser beam 12 is reflected and directed backward to the scanning timing control optical system for synchronization of scanning.

As shown in Figures 2 and 3, the scanning timing control optical system comprises a reflection mirrors 27 and 29 disposed behind the second reflection mirror 26, and a relay lens element 30 disposed between the reflection mirrors 27 and 29. The scanning timing control optical system is accompanied by an optical sensor 32 such as a photoelectric element sensor covered by a protective transparent glass 28. The reflection mirror 29 is located on a bottom wall 10d of the box casing 10, and the reflection mirror 27 is located on the bottom wall 10d of the box casing 10 as shown in Figure 3 but slightly off set sideways from the reflection mirror 29 as shown in Figure 2. Although the reflection mirror 29 is depicted on a straight path of the laser beam for an easy understanding in Figure 2, it is actually located behind the second reflection mirror 26 as shown in Figure 3. The reflection mirror 29 is small in size and located in the box housing 10 so as to receive and reflect back the laser beam Lb that is reflected forward by the second reflection mirror 26 at the very moment that the polygon mirror 17 turns and changes its active reflection surface on which the laser beam Lb directed by the laser beam projection optical system impinges from one to another, in other words, to receive only the laser beam Lb reflected by an extreme end of a given effective range of the reflection mirror 26 that is allowed for line scanning. The laser beam Lb reflected by the extreme end of the second reflection mirror 26 (which is hereafter referred to a synchronous laser beam) is reflected by the reflection

mirror 29 and directed back to the second reflection mirror 26. Then the synchronous laser beam Lb is reflected again by the second reflection mirror 26 and directed to the reflection mirror 27 through the relay lens element 30 and further reflected downward by the reflection mirror 27 and directed to the optical sensor 32. The optical sensor 32 covered by the protective glass 28 is secured to a base board 31.

In response to reception of the laser beam Lb, the optical sensor 32 provides a control circuit of a printer that is equipped with the optical scanning device 100 with a synchronous signal for a start or an end of each line scanning of a scanning subject medium Sm.

Figures 4 to 6 show details of a stepped frame mount 120 of the dust proof chamber 20. As shown in Figure 4, the stepped frame mount 120, which is structured in a rectangular recess 20e formed in a bottom floor 20d of the dust proof chamber 20, comprises an outer rectangular fitting frame shoulder 120a and an inner rectangular support frame shoulder 120b, both of which are shaped in conformity to an outer configuration of the rectangular base board 18. The inner rectangular support frame shoulder 120b is formed so as to be uneven to the outer rectangular fitting frame shoulder 120a with a difference of, for example, approximately 0.5 mm at most. Specifically, the stepped frame mount 120 is configured such that the base board 18 is smoothly fitted in the outer rectangular fitting frame shoulder 120a and supported by the inner rectangular support frame shoulder 120b from the back. The stepped frame mount 120 at its four corners is provided with corner settings 120c which are level with the outer rectangular fitting frame shoulder 120a and to which setting screws are fastened to secure the base board 18. The stepped frame mount 120 provides a clearance or difference in level of 0.5 mm at most between the base board 18

mounted thereon and the inner rectangular support frame shoulder 120b.

Taking relative dimensional accuracy of the stepped frame mount 120 and the base board 18 into consideration, it is preferred to support the base board 18 on the stepped frame mount 120 at the four corner fittings 120c rather than supporting directly by the inner rectangular support frame shoulder 120b. Further the clearance between the base board 18 mounted thereon and the inner rectangular support frame shoulder 120b, i.e. a difference between the outer rectangular fitting frame shoulder 120a and the inner rectangular support frame shoulder 120b, is desirable to be as small as possible and allowed up to approximately 0.5 mm at most in light of dimensional accuracy of the dust proof chamber 20.

In operation of the optical scanning device 100 thus constructed, even when the polygon mirror 17 causes such a current of air as hitting against walls of the dust proof chamber 20 with the result of generating a turbulent air flow, the stepped frame mount 120 is not conducive to encouragement of the turbulent air flow because of preventing it from penetrating under the base board 18. As a result of which the polygon mirror 17 is effectively prevented from causing fluctuations of rotation, so as to keep the optical scanning device from an occurrence of inaccurate and unstable scanning.

It is to be understood that although the present invention has been fully described by way of the preferred embodiments thereof with reference to the accompanying drawings, various variant and other embodiments may occur to those skilled in the art. Unless these variants and embodiment depart from the scope of the present invention, they are intended to be covered by the following claims.

4. An optical scanning means as defined in claim 3, wherein each said setting surface is uneven with a difference of approximately 0.5 mm at most.

5. An optical scanning device as defined in claim 4, wherein said mounting means further comprises a fitting frame which is shaped in conformity with said base board so as to receive said base board therein and even with said setting surface of said support frame.

6. An optical scanning device as defined in claim 3, wherein said base board has a generally rectangular shape having a thickness, said setting surfaces are arranged at four corners of said support frame with a difference of approximately equal to said thickness of said base board from said support frame.

7. An optical scanning device as defined in claim 3, wherein said mounting means is provided in a recess formed in a bottom floor of a housing in which said polygon mirror is arranged.

8. An optical scanning device for scanning a subject medium with a scanning beam that is oscillated by a polygon mirror driven by an electric motor, said optical scanning device comprising:

a generally rectangular box-shaped housing;

a polygon mirror unit including at least a polygon mirror and a generally rectangular base board to which said polygon mirror is fixedly attached;

12. An optical scanning device as defined in claim 10, wherein said fitting frame has a depth equal to a thickness of said base board.

13. An optical scanning device as defined in claim 10, wherein said mounting means is provided in a recess formed in a bottom floor of said dust proof chamber.

DISCLOSURE OF THE INVENTION

An optical scanning device has a polygon mirror unit which is housed in a dust proof chamber and mounted on a mount configured so as to prevent generation of turbulence of a current of air that is caused due to high speed rotation of the polygon mirror which leads to fluctuations of rotation of the polygon mirror.

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FIG. 2

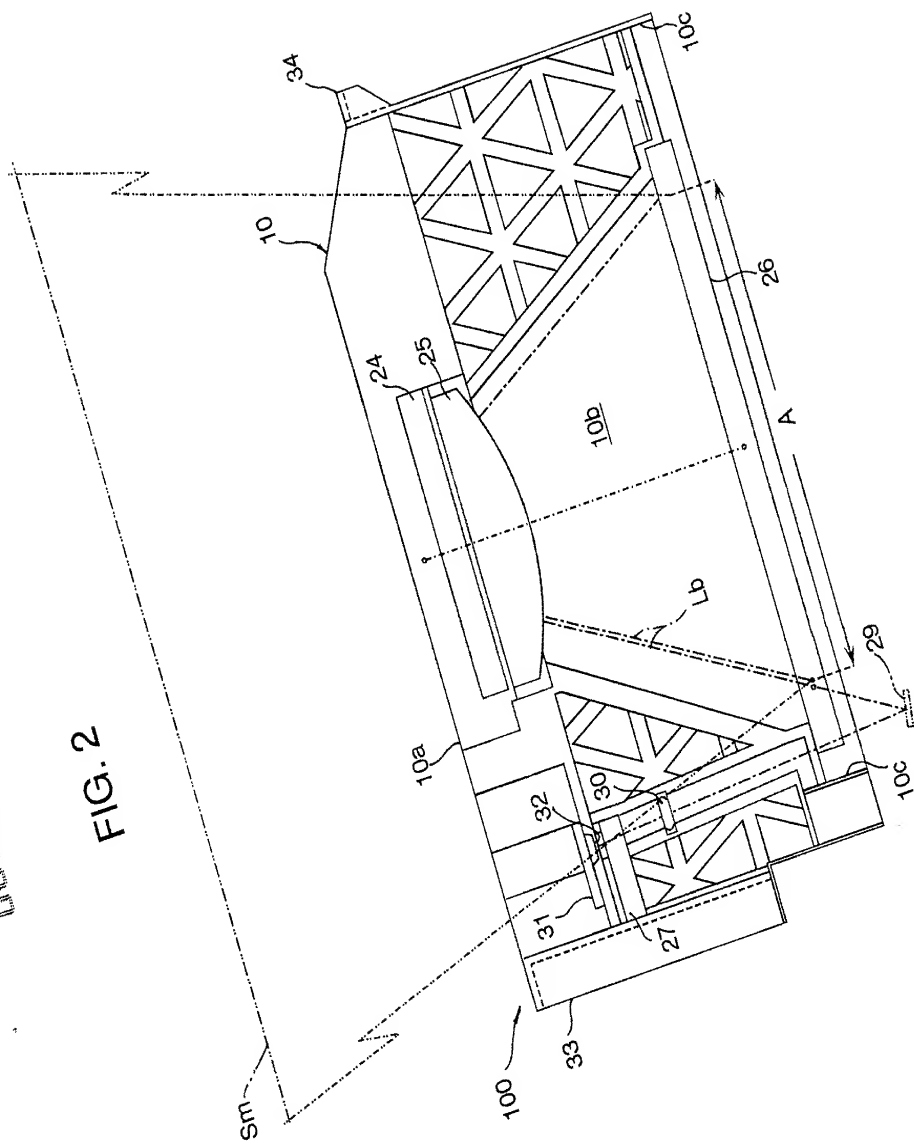


FIG. 3

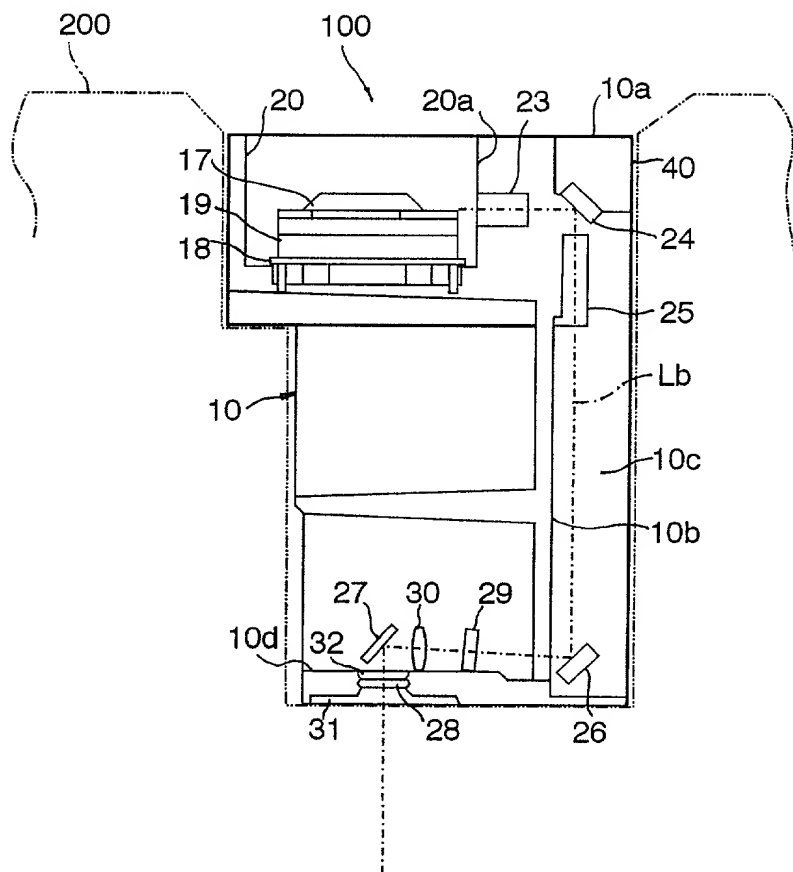


FIG. 6

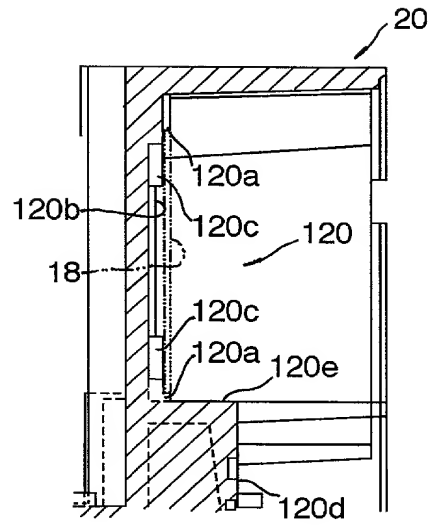


FIG. 7

